LCD CONNECTOR FOR PRINTED CIRCUIT BOARDS

The present application claims priority to U.S. Provisional Application No. 60/203,239, filed May 8, 2000 entitled "LCD Connector Having Integrated Preload Feature"; U.S. Provisional Application No. 60/203,242, filed May 8, 2000 entitled "LCD Surface Mount Connector; U.S. Provisional Application No. 60/202,400, filed May 8, 2000 entitled "LCD Connector with Flexible Leaf-Spring Housing"; and U.S. Provisional Application No. 60/202,399 filed May 8, 2000 entitled "LCD Connector with Metallic Spring Contacts".

FIELD OF THE INVENTION

This invention is directed to the manufacture of a connector for liquid crystal displays ("LCDs") that is adapted for electrical connection of an LCD panel and a conductive portion of a printed wiring board (PWB) or printed circuit board (PCB). This invention is further directed to a method of affixing an LCD panel to a PWB or PCB through an insulative connector having a plurality of contacts mounted thereon. As used herein, the terms PWB and PCB will be used interchangeably to denote a substrate having conductive elements to which an LCD is electrically connected.

BACKGROUND OF THE INVENTION

Liquid crystal displays ("LCDs") are being aggressively integrated into a multitude of contemporary electronic devices that previously employed cathode ray tubes (CRTs). "Liquid crystal" is a term that indicates the status of a substance that is neither solid nor liquid. When coming into contact with a grooved surface in a fixed direction, liquid crystal molecules line up in parallel along the grooves. Light travels through the spacing of the molecular arrangement. As the molecule arrangement is twisted, the light also "twists" as it passes through the liquid crystals. When a voltage is applied to the liquid crystal structure, the molecules rearrange themselves and the twisted light passes straight through. When voltage is applied to a

combination of two polarizing filters and twisted liquid crystal, it becomes an LCD display. This is the principle behind conventional twisted nematic (TN) LCDs.

It is desirable to exploit the unique advantages of LCD displays, such as their compact size, thin profile, lightweight, low power consumption and ability to withstand elevated temperatures and vibrations, to produce items that are more compact and lightweight than CRTs. This means that LCDs can be used in many applications where a large CRT monitor does not fit or is impractical. Such products include LCD TVs, view cams, portable information tools (i.e. PDAs), computer monitors, A/V equipment, car navigation systems, game devices, large projection TVs and similar products. LCDs also deliver comparable performance in the display of color, resolution and brightness and further obviate the emission of harmful radiation attributable to emission by CRT monitors.

The typical LCD module includes a liquid crystal matrix mounted in or to a substrate that includes a plurality of discrete conductive regions disposed thereon. A liquid crystal cell is acquired by forming the requisite electrodes and then forming an alignment layer within which liquid crystal particles align themselves. Upper and lower glass substrates are thereafter coupled to one another and plastic beads are sandwiched therebetween. The substrates are then fixed, after which liquid crystals are injected into spaces between the plastic beads. Sealing of the LCD module is completed when external electronic elements, along with a driver, are connected to the electrodes of the finished cell.

Elastomeric connectors effect the most common method of connection of LCD modules to the conductive portion of a printed wiring board (PWB) or printed circuit board (PCB). Such connectors are generally silicone rubber strips made up of sequentially spaced conductive and non-conductive materials. Typical elastomeric connectors have at least one row of alternating layers of conductive and insulative compressible material that may be surrounded on its sides by a rubber supporting layer. The elastomeric connector is used in assemblies by mechanically confining the connector sides and compressing the connector through its height, thereby pressing the conductive elements in the connector onto conductive pads on the PWB and corresponding conductive pads on the LCD.

Increasing use of LCDs in delicate and complex electronic devices, however, increases the number of applications in which numerous interconnections must be made between the LCD and the PWB. Since there is limited space for these connections, it is imperative that the LCD pads and the PWB pads be tightly aligned over one another and that there be minimal angular skew in the conductive elements in the elastomer. This angle therefore becomes particularly important as the height of the connector increases. Absent such precise configuration, the conductors in the connector might not connect to the appropriate corresponding pads on the LCD and the PWB. In addition, since the connector is made from a rubbery material that is susceptible to movement under elevated temperature and vibrations, the retention of the elastomeric connectors to the PCB is minimal.

It is therefore desirable to provide an LCD surface mount connector that overcomes the problems inherent in elastomeric connectors. Particularly, it is desirable to provide such a connector that predictably and reliably retains conductive elements in precise alignment with one another.

SUMMARY OF THE INVENTION

It is therefore an advantage of the present invention to provide an improved LCD surface mount connector that obviates the above-described shortcomings of conventional elastomeric contacts.

It is another advantage of the present invention to provide an LCD surface mount connector that retains a plurality of contacts in an inexpensively molded insulative housing.

It is an additional advantage of the present invention to ensure that conductive elements of an LCD connector are correctly aligned with terminal pads of adjacent circuits during assembly of the connector between the circuits.

In accordance therefor with a particular arrangement of the invention, an electrical connector is provided for establishing electrical connection between a conductive portion of an LCD display and conductive elements of a printed circuit board. The connector includes a substantially planar integrally formed connector housing supportable on the printed circuit board, the housing having an upper surface, a lower surface and a peripheral wall. A plurality of electrical contacts are supported by the housing, each contact including an interior contact extent having a deflectable spring-like portion defined thereat. The interior contact extent provides for electrical engagement with the LCD conductor portion. Each electrical contact includes an exterior contact extent for termination to the printed circuit board. Each contact further includes a mid-section extent between the interior contact extent and the exterior contact extent, the mid-section contact extents being secured to the housing allowing free connection of the interior contact extent to the printed circuit board and deflectable connection of the interior contact extent to the LCD conductor portions.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a top perspective view of one embodiment of an LCD surface mount connector of the present invention.

Figure 2 shows a bottom perspective view of the LCD surface mount connector of Figure 1.

Figure 3 shows a top perspective view of a plurality of contacts employed in the connector of Figures 1 and 2 prior to an insert molding operation.

Figure 4 shows a bottom perspective view of an alternate form of an LCD surface mount connector of the present invention.

Figure 5 shows a top perspective view of a plurality of contacts employed in the connector of Figure 4 prior to coupling of the contacts to a connector housing.

Figures 6 and 6A show a bottom perspective view and a top perspective view, respectively, of another alternative form of an LCD surface mount connector of the present invention having press fit contacts mounted in an insulative housing.

Figure 7 shows a front perspective view of an insulative housing having slots for retention of contacts therein.

Figures 8 and 8A show top and bottom perspective views, respectively, of a barbed contact employed in the connector of Figures 6 and 6A.

Figure 9 shows an exploded view of a portion of the connector of Figures 6 and 6A having the contact of Figures 8 and 8A embedded therein

Figure 10 shows a top plan view of an alternate preferred embodiment of an LCD surface mount connector of the present invention having contacts with portions bendable about an insulative housing for attachment thereto.

Figure 10A shows a contact of the connector of Figure 10 having bendable portions defined thereon.

Figure 11 is a side view of the connector of Figure 10.

Figure 12 shows a top perspective view of a further embodiment of an LCD connector of the present invention.

Figure 13 shows a side view of the LCD surface mount connector of Figure 12 as supported by a PCB.

Figures 14 and 14A show top and bottom perspective views, respectively, of the connector of Figures 12 and 13.

Figures 15 and 15A show top and back perspective views, respectively, of an alternate preferred embodiment of the LCD connector of the present invention.

Figures 16 and 16A show top and bottom perspective views, respectively, of a contact used in the connector of Figures 15 and 15A.

Figure 17 shows a top perspective view of another embodiment of an LCD connector of the present invention.

Figure 17A shows a front perspective view of the LCD surface mount connector of Figure 17.

Figures 18 and 18A show alternate front and top perspective views, respectively, of the connector of Figures 17 and 17A.

Figure 19 shows a bottom perspective view of the connector of Figures 17 and 17A and Figures 18 and 18A.

Figure 20 shows a contact used in the connector of Figures 17-19 prior to preloading at a deflectable extent thereof.

Figure 21 is a top perspective view of yet a further embodiment of a LCD connector of the present invention.

Figure 22 shows a side elevation view of the LCD connector of Figure 21.

Figure 23 is a front elevation view of the LCD connector shown in Figure 21.

Figure 24 is a top plan view of the LCD connector shown in Figure 21.

Figure 25 is a bottom plan view of the LCD connector shown in Figure 21.

Figure 26 is an enlarged side view of one of the contacts contained in the LCD connector of Figure 21.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention provides for an LCD surface mount connector that eliminates the angular skew and consequential connection problems that are inherent in conventional elastomeric connectors. In one arrangement of the present invention shown with respect to Figures 1-11, the connector utilizes a plurality of contacts of varying configuration that are laterally spaced in an insulative connector housing. The contacts have resilient undulation spring-like portions at an extent thereof protruding normally from the housing and a tail portion for termination with a PWB. The contacts are fabricated for easy coupling with the housing wherein coupling effects alignment of the contacts and ensures proper mechanical and electrical engagement between the contacts and corresponding pads on the conductive portions of the LCD and the PWB.

Now referring to the drawing figures, Figures 1 and 2 show an LCD surface mount connector 10 in accordance with a particular arrangement of the present invention. Connector 10 includes a pier 12 having a top planar surface 12a, a bottom planar surface 12b and a peripheral side wall 12c extending therebetween. Connector 10 further includes one or more securement members 14 protruding normally from bottom surface 12b to effect securement of connector 10 to a correspondingly configured aperture in a PWB. Pier 12 is desirably fabricated from an insulative plastic which is easily molded such as by RTM or injection molding processes.

Pier 12 supports a plurality of laterally spaced contacts 16 thereby. Each contact 16 is provided in a clothespin-type configuration wherein a spring-like undulation 16a lies in parallel spaced relation to a substantially planar base 16b. Each contact 16 further includes a tail portion 16c that protrudes from a portion of side wall 12c opposite that from which base 16 extends.

As further shown in Figure 3, each contact 16 has a slot 18 defined therewithin. Contacts 16 are shown while still attached to a common ribbon 20 of a conductive metal from which contacts 16 are stamped. Slots 18 are elevated by a distance d above a plane in which base 16b lies, however it is understood that such distance d is mutable to accommodate the performance requirements of the connector. Distance d provides sufficient elevation to enable plastic flow of the insulative material of pier 12 to flow through slots 18 during an insert molding operation. Contacts 16 are thereby retained in alignment relative to one another and relative to pier 12 so as to effect sufficient aligned connection with requisite conductive elements on the LCD display and the PWB.

Now referring to Figures 4 and 5, an alternative LCD surface mount connector 30 is provided which has a housing 32 with a substantially planar top surface 32a, a parallel bottom surface 32b and a peripheral side wall 32c bounded therebetween. Like pier 12 of connector 1, one or ore securement members 34 protrude normally from bottom surface 32b for alignment and securement with correspondingly configured apertures in a PWB. A plurality of cold-staked posts 35 also depend normally from bottom surface 32b so as to be linearly spaced relative to one another. Housing 32 is desirably fabricated from an insulative plastic material.

Connector 30 further includes a plurality of contacts 36 that are stamped from a common ribbon 40 of a conductive metallic material as shown in Figure 5. Contacts 36 are similar to contacts 16, having a spring-like undulation 36a extending in spaced linear relation to a co-terminal base 36b and a tail portion 36c that protrudes normally from side wall 32c in an opposing direction relative to base 36b. Each contact 36 further includes a mid-section 36d elevated by a distance d above a plane in which base 36b and tail portion 36c lie.

Contacts 36 are coupled with housing 32 so that the contacts are alternatingly disposed in housing 32 relative to posts 35 (as shown in Figure 4). Contacts 36 are fitted into correspondingly configured recesses 38 in housing 32 so as to establish a friction fit therewithin. Contacts 36 may also be retained in housing 32 by any other appropriate coupling means, such as adhesive or the like. Posts 35 may alternatively be swaged over contacts 36 so as to ensure alignment and securement thereof.

An alternate form of the LCD surface mount connector of the present invention is further illustrated in Figures 6 and 6A. Connector 50 includes an insulative housing 52 having a top surface 52a, a bottom surface 52b and peripheral said walls 52c bound therebetween. Housing 52 includes one or more securement members 54 depending normally from bottom surface 52b.

As further illustrated in Figure 7, upper surface 52a is alternatingly interrupted by contact insertion cavities 53 having contact insertion recesses 58 defined on either side thereof. Recesses 58 provide sufficient space for press fit insertion of a contact 56 therewithin. Cavities 53 further provide sufficient open space to accommodate flexing of a contact extent thereinto upon engagement of the contact with corresponding conductive portions of the LCD.

Referring to Figures 8 and 8A, contacts 56 used in connector 50 are cantilever style press fit contacts formed from a conductive metal material. Each contact includes a spring-like undulation 56a at an extent thereof which depends from a planar base 56b. A tail portion 56c is defined at an opposite extent of each contact, which tail portion extends from housing 52 in a direction opposite to that from which base 56b extends. Each contact 56 further includes a mid-section 56d whereupon one or more barbs 57 are defined. Barbs 57 are insertably accommodated within recesses 58 to provide a friction or press fit between barbs 57 and housing 52. Figure 9, which shows an exploded view of the circled portion of Figure 6A, illustrates how a wall portion of housing 52 defined within recess 58 catches barbs 57 so as to retain contacts 56 therewithin.

Another alternate form of the LCD surface mount connector of the present invention is shown in Figures 10 and 11. Similar to the previously described connectors, an LCD surface mount connector 70 has an insulative housing 72 supporting a plurality of conductive metal contacts 76 thereby. Housing 72 has upper and lower surfaces 72a and 72b, respectively, having a peripheral side wall 72c defined therebetween. Housing 72 further includes alternatingly disposed and laterally spaced recesses 78 that accommodate flexing of a contact portion therein as described further hereinbelow.

A contact 76 that is used in connector 70 is further shown in Figures 10a and 11. Connector 76 has a deflectable spring-like undulation 76a at an extent thereof which depends from a generally planar base 76b. A tail portion 76c is defined at an opposite extent of contact 76 wherein tail 76c protrudes from side wall 72c in a direction opposite that of base 76b. Contact 76 further includes a mid-section 76d having bendable tines 77 defined thereon. Tines 77 are folded bendable in a staple-like fashion within recesses 78 of housing 72 so as to effect secure engagement therewith.

In another arrangement of the present invention shown with respect to Figures 12-16A, the connector utilizes a flexible connector housing supporting a plurality of alternatingly and laterally spaced contacts thereby. Each contact is a generally planar member having a resiliently deflectable undulation at an extent thereof wherein each undulation has a contact point that establishes mechanical an electrical engagement with a mating component in an LCD cell. The housing itself is used as a spring member that exerts a spring force against the mating component so as to achieve high normal forces while maintaining a low connector profile.

Now referring to the drawing figures, Figures 12 to 14A show an LCD connector 110 of the present invention that is securable to a PCB 113 (shown in Figure 13). Connector 110 includes a housing 112 having a top planar surface 112a, a bottom planar surface 112b and a peripheral sidewall 112c extending therebetween. Connector 110 further includes one or more securement members 114 depending normally from bottom surface 112b to effect securement of connector 110 to a correspondingly configured aperture in PCB 113. Housing 112 is desirably fabricated from an insulative plastic which is easily molded such as by RTM or injection molding processes

Housing 112 supports a plurality of laterally spaced contacts 116 thereby. As further shown in Figure 15, each contact 116 includes a resiliently deflectable spring-like undulation 116a that lies in parallel spaced relation to top surface 112a. Each undulation has a contact point 117 defined thereon which establishes the site of contact with a mating component. Each contact 116 further includes a tail portion 116c that protrudes from a portion of sidewall 112c opposite

that from which undulation 116a extends. Tail portion 116c enables termination of the connector with PCB 113.

Contacts 116 are desirably assembled with housing 112 by performing an insert mold operation wherein housing 112 is directly molded around the contacts. In the alternative, contacts 116 may be press fit into correspondingly configured cavities in housing 112 so as to effect frictional engagement therewith. Such engagement may be achieved with or without the use of an adhesive or the like. Contacts 116 are thereby retained in alignment relative to one another and relative to pier 112 so as to effect sufficient aligned connection with requisite conductive elements on the LCD display and the PCB.

Housing 112 desirably retains a flexible condition wherein the housing itself acts as a leaf spring when connection therewith is established by a mating component. As the component exerts a downward force toward PCB 113, housing 112 predictably exerts an upward force in response thereto, which is normal to contact point 117. Such normal force further ensures reliable contact between connector 110 and a mating component in engagement therewith.

Now referring to Figures 15 and 15A, another alternate form of an LCD connector of the present invention is shown. Connector 30 also includes a flexible housing 132 having an upper surface 132a, a lower surface 132b parallel thereto and a peripheral sidewall 132c defined therebetween. Connector 130 defines a plurality of recesses 138 therewithin which alternatively accommodate a corresponding plurality of laterally spaced contacts 156 therein.

As further shown in Figures 16 and 16A, contacts 156 are generally planar members having a deflectable, spring-like undulation 156a at an extremity thereof that terminates a base portion 156b. A tail portion 156c is defined at an opposite extent of contact 156 for termination to a PCB. Contacts 156 are desirably press fit into cavities 138 and may be secured therewithin by one or more barbs 157 depending from a midsection 156d thereof. Securement of the contacts to the housing may also be effected by other well-known means.

In a further arrangement of the present invention shown in Figures 17-20, the connector utilizes a plurality of contacts having a clothespin type configuration wherein a deflectable extent of the contact may be spring loaded to withstand normal forces applied thereto. The contacts are easily assembled with an insulative connector housing such that assembly of the housing ad contacts effects alignment of the contacts and ensures proper mechanical and electrical engagement between the contacts and corresponding pads on the conductive portions of the LCD and the PWB.

Now referring to the drawing figures, Figures 17 to 20 show an LCD connector 210 of the present invention. Connector 210 includes a housing 212 having a top planar surface 212a, a bottom planar surface 212b and a peripheral sidewall 212c extending therebetween. Connector 210 further includes one or more polarizing retention pegs 214 protruding normally from bottom surface 212b to effect securement of connector 210 to a correspondingly configured aperture in a PCB. Housing 212 is desirably fabricated from an insulative plastic which is easily molded such as by RTM or injection molding processes.

Housing 212 supports a plurality of laterally spaced contacts 216 thereby. As further shown in Figure 20, each contact 16 is provided in a clothespin-type configuration wherein a spring-like undulation 216a lies in parallel spaced relation to a substantially planar base 216b to define a preload window 217 therebetween. Preload window 217 sustains the undulation in a pre-loaded condition so as to withstand elevated normal forces thereon and maintain a low connector profile. Each contact 216 further includes a tail portion 216c that protrudes from a portion of sidewall 212c opposite that from which base 216b extends.

Contacts 216 are desirably assembled with housing 212 by performing an insert mold operation wherein housing 212 is directly molded around the contacts. In the alternative, contacts 216 may be press fit into correspondingly configured cavities in housing 212 so as to effect frictional engagement therewith. Such engagement may be achieved with or without the use of an adhesive or the like. Contacts 216 are thereby retained in alignment relative to one another and relative to pier 212 so as to effect sufficient aligned connection with requisite conductive elements on the LCD display and the PWB.

In yet a further arrangement of the present invention shown in Figures 21-26, the connector utilizes a plurality of spring contacts that are laterally spaced in an insulative connector housing. The contacts can have resilient undulation spring-like portions at a looped extent thereof and a tail portion for termination with a PWB. The contacts are fabricated for easy coupling with the housing wherein coupling effects alignment of the contacts and ensures proper mechanical and electrical engagement between the contacts and corresponding pads on the conductive portions of the LCD and the PWB.

Now referring to the drawing figures, Figures 21-26 show an LCD connector 310 of the present invention that is securable to a PCB (not shown). Connector 310 includes an insulative housing 312 supporting a plurality of contacts 314 that are laterally spaced in the housing 312. Each of the contacts 314 has a front resilient undulation spring-like portion defined by a loop extent 314a. Each of the looped extents 314a comprises an upper contact point 314b for making engagement to an LCD. Contact portions 314b terminate in downwardly projecting extents 314c which are suitably contained within a slot in insulative housing 312 for captive movement upon connection with an LCD. Electrical contacts 314 include intermediate mid-sections 314d for fixed securement to insulative housing 312. Each electrical contact terminates at its rear portion in a tail 314e for electrical connection with a printed wiring board. The mid-section 314d is offset from the plane of tail 314e.

Contacts 314 are desirably assembled within housing 312 by performing an insert mold operation wherein housing 312 is directly molded around the contacts 314. In the alternative, contacts 314 may be pressed fit into correspondingly configured cavities in the housing 312 so as to effect frictional engagement therewith. Contacts 314 are thereby retained in alignment relative to one another so as to effect sufficient aligned connection with requisite conductive elements on the LCD display and the PWB.

While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the fundamental teachings of the invention. The matter set forth in

the foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective based on the prior art.